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NEWS

PROJECT

CLAIRO - CLear AIR and Climate Adaptation in Ostrava and other cities

Ostrava, Czech Republic

TOPIC

Air quality

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CLAIRO pilots novel solutions to improve plant health

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When the goal is to capture air pollutants with newly planted urban vegetation at an industrial site exposed to various pollutant types, then proper greenery care is essential to ensure long-term health of trees and shrubs. As part of the CLAIRO project a smart and environmental-friendly plant treatment will continue to be applied in Ostrava for years after project closure, accompanied with a long-term monitoring activity.

The CLAIRO project strived to optimize vegetation so that it is able to filter air pollutants in urban neighbourhoods affected by poor air quality. The most obvious factors that determine the effectiveness of pollutant capture are the structure and the composition of the greenery. However, greenery care especially at sites affected by air pollution and soil contamination is as much relevant for filtration efficiency as proper design of the greenery. In an industrial urban area exposed to various types of pollution, an ongoing treatment is required to maintain the proper physiological functions of the plants.

Trees and shrubs, which are in better health condition as a result of a specific treatment, photosynthesize better and have denser foliage, and all these changes have a direct and positive effect on pollutant capture.

Plant hormones and biostimulants put to use to increase plant growth.

A smart and environmental-friendly plant treatment has been applied twice a year in 2021 and 2022 under CLAIRO by the Palacky University Olomouc in Ostrava at the Radvanice and Bartovice target sites of the project. The innovative treatment piloted in Ostrava was based on the use of biostimulants and plant hormones. The application of this innovative treatment contributes in the long-term to the improvement of the basic physiological parameters of new plantings.

Biostimulants are biologically active substances that promote plant growth and strengthen plant defences against various stress factors. Their use has a huge potential in reducing the negative impacts of chemical fertilizers and pesticides from which they differ in a number of key aspects. They are not synthetic, they do not contain a high percentage of active substances, they do not provide nutrients directly to the plants, as well as they do not

protect them directly from pathogens. Still, their active ingredients affect the metabolism of the plant and trigger processes that generally improve its growth and health. The biostimulant preparation that was selected by the research team of Palacky University Olomouc for the treatment under CLAIRO contained amino acids, anti-stress substances and seaweed extracts.

As part of the innovative treatment piloted in the CLAIRO project, biostimulants were fortified by cytokinins, a specific class of plant hormones. Cytokinins are very active growth regulators and they increase the resistance of plants to various abiotic stress factors. For the treatment, a specific cytokinin derivative was selected that had been synthetized earlier by the Palacky University Olomouc.

Three different treatment types have been applied by Palacky University in CLAIRO on the planted greenery. Only commercial inorganic fertilizer was used in treatment A, the soil and plants are treated by biostimulants in treatment B; and cytokinins were added to the biostimulants in treatment C (innovative treatment). The application of the three treatment types was repeated in the pilot across different soil types.

The vitality of plants monitored for five years after project closure.

As the planting of the greenery took place only one year before the end of the project, the treatments and the monitoring activity will be carried out for five years following the closure of the project, so that the impacts can be evaluated in the long-term. Additional information on the innovative treatment is available under the 2nd Zoom-in paper of CLAIRO.

A number of parameters are monitored under CLAIRO that indicate the impact of the various treatment types on the vitality of the green infrastructure. These parameters are linked to the chlorophyll content of the leaves, the exchange of oxygen and carbon dioxide in the leaves, and the rate of transpiration.

Structural and functional properties of the plant canopies were measured using common vegetation indices, the Normalized Difference Vegetation Index (NDVI) and the Photochemical Reflectance Index (PRI).

NDVI quantifies vegetation and it is useful in assessing vegetation density and changes in plant health. NDVI is calculated as a ratio between the red light, which is absorbed by vegetation and the near-infrared light, which is strongly reflected by foliage. Healthy vegetation absorbs most of the visible light that falls on it, and reflects most of the near-infrared light, while unhealthy vegetation reflects more visible light and less near-infrared light.

The Photochemical Reflectance Index is used to assess general ecosystem health. The PRI signals changes in carotenoid specific pigments such as xanthophyll in the foliage that indicate the efficiency of photosynthesistic light use and the rate of carbon dioxide uptake by the leaves. These parameters indicate and though this and vegetation productivity and stress.

The Normalized Difference Vegetation Index and the Photochemical Reflectance Index were measured and calculated under CLAIRO using a handheld instrument, PolyPen that examines the wavelength of reflected light.

Results indicate good condition of trees across treatment types.

At the two target sites in Ostrava, Radvanice and Bartovice, the new greenery was planted from mid-March to early May in 2021. Following planting the first treatment took place in June 2021. Measurements were carried out by Palacky University on the new planting at the Radvanice site seven days following the first treatment. The second measurement was undertaken at the end of September 2021.

In 2021 all monitored trees were found to be in very good physiological condition regardless of their treatment type. All of the planted trees were thriving, with the exception of only a couple of mountain pine trees, which did not survive at the Bartovice site, where the conditions are harsher. The results of the first measurements undertaken in June 2021 have shown a slightly increased relative chlorophyll content and Normalized Difference Vegetation Index (NDVI) in case of plants that had been treated by biostimulants (treatment B). This result was actually expected by the researchers of Palacky University Olomouc, since very short time had passed since planting, therefore abiotic stressors could not take effect on the new vegetation.

In September 2021 following the second treatment, a second round of measurements was carried out, this time at the Bartovice site of CLAIRO. The results were very similar: once again, all values indicated a good physiological condition of the monitored trees. This time, the highest Vegetation Index (NDVI) was measured in plants treated with biostimulants fortified by cytokinins (treatment C). Otherwise, quite similar relative chlorophyll content was

measured across each treatment type. The results have shown that half a year after planting is still way too early to make a difference in the effectiveness of various treatment methods.

At the beginning of the project the biggest concern of the research team of Palacky University Olomouc was that the majority of the trees might be lost as a result of the exposure to multiple abiotic stressors, and the primary goal of CLAIRO, to systematically decrease air pollution at the target sites with the help of greenery would not be fulfilled. Eventually these fears turned out to be unfounded.

In 2022, following the year of the planting, the new vegetation was once again treated twice by the researchers of Palacky University, this time in April and in September. Much to the surprise of the team of Karel Dolezal at Palacky University the measurements following the treatments have shown that trees are still in good physiological condition. Over 95% of the plants have survived and were vigorous one and a half year after planting. Furthermore, there was no significant difference in the health status of the trees based on how they were treated, not even between commercial and innovative treatments.

According to Karel Dolezal, there are two main reasons for these results. The first is that it still seems to be too early to detect significant differences in the health status of plants, as they were not yet affected by the pollution. The other reason is linked to the planning and the execution of greenery planting. Appropriate plant species were selected, which could adapt well to the local unfavourable conditions and which have a higher tolerance to air pollution. During planting a large amount of good quality soil was supplied at the sites, and the roots simply still have not grown through to the polluted soil.

Although in the light of the monitoring results the testing of the efficiency of various treatment was not possible, greenery care through safeguarding the trees contributed to the achievement of the primary goal of the project, pollution mitigation at the target sites with the help of greenery.

It is expected though that at least in Bartovice the impacts of the extreme conditions at the site will certainly manifest themself in the upcoming years. Therefore, longer term monitoring of the physiological state of the new plantings is essential, that lasts at least four or five years after the start of treatment.

Karel Dolezal, the Head of the Department of Chemical Biology at Palacky University Olomouc highlighted the following about the results of the experiments with innovative soil and plant treatment in Ostrava:

> Photosynthetic as well as other physiological parameters of plants treated by innovative combination of phytohormones and biostimulants were in the range typical for non-stressed and healthy individuals. Only few individuals, mainly mountain pine trees were needed to be replaced one year after the planting. Due to well selected standard treatment as well as well performed planting and locality preparation the majority of all planted trees performed well, which was the main aim of the project. The main added value of the innovative treatment is the absence of inorganic fertilizers.

There is a huge potential in using preparations containing biostimulants and plant hormones for helping plants overcome various forms of abiotic stress. Such innovative solutions can be used to strengthen both existing green infrastructure and new plantings of greenery at sites expose to a combination of different forms of abiotic stress. And it is not a negligible aspect that this method is fast, simple and inexpensive. The solution developed by Palacky University Olomouc can serve as a viable alternative to conventional inorganic fertilizers, particularly in locations where plantations are exposed to industrial pollution.

Karel Dolezal has stressed that the application of the innovative soil and plant treatment under the CLAIRO project opens the door for further research:

> The results of CLAIRO confirmed the usefulness of our innovative treatment for plants grown in stress conditions and therefore we are going to use this treatment also in following projects.

This innovative practice piloted in Ostrava open doors to other cities that aim to safeguard their existing or new plantings from various abiotic stress factors.

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